DOCUMENT RESUME

ED 242 380 JC 840 171

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TITLE High Technology Training at Greenville Technical College.
INSTITUTION Greenville Technical Coll., S.C.
PUB DATE [84]
NOTE 37p.
PUB TYPE Reports - Descriptive (141) -- Viewpoints (120)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Automation; Community Colleges; Computer Oriented Programs; Cooperative Programs; Demand Occupations; Labor Force Development; Program Descriptions; Program Development; *School Business Relationship; *Technical Education; *Technological Advancement; Two Year Colleges

ABSTRACT

These three papers focus on various aspects of high technology training at Greenville Technical College (GTC). First, "High Technology and the Community College," by Thomas E. Barton, discusses what high technology should mean to educators and argues that changes in the nature of industrial production require that community colleges not only keep abreast of technological change but be in the vanguard of that process. This paper examines the ways in which GTC has strengthened its relationship with business and industry through efforts such as its Advanced Machine Tool Resource Center, Computer Aided Design/Computer Aided Manufacturing Center, and network of advisory committees. Next, "High Technology Training: Recent Accomplishments," by Howard Turner, discusses the progress made by GTC in keeping up with developments in computer numerical control metal cutting, computer-aided design, process control instrumentation, microprocessors, computer electronics and programming, and office automation. Finally, "Meeting the Challenge of High Technology," by Melvin Smith, examines the impact of computer-aided engineering, design, and manufacturing and robotics on the manufacturing industry; highlights the need for technology and engineering graduates to fill new positions; and describes additional ways in which GTC is meeting the challenges of technological advancement and employment needs. (HB)

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HIGH TECHNOLOGY TRAINING AT GREENVILLE TECHNICAL COLLEGE

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HIGH TECHNOLOGY AND THE COMMUNITY COLLEGE

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The term "high technology" is used very freely these days. It is used in business, in industry, in health care--throughout the workplace. It is used frequently in education at all levels. If today ten people were asked to define "high technology," we could probably expect to get ten different interpretations. However, the composite of all those definitions would be "the application of the computer in the design, manufacture, and marketing of goods and services." For our purposes, we will choose, then, to use that definition.

Which leads me to ask: What does high technology mean to you and me as educators? And particularly for this discussion, what does high tech mean to a community college?

Tersely put, it should mean a great deal to us. We have a two-fold mission now--to train men and women for today's jobs and equip them for living in today's world and, more importantly, to fix our eyes years ahead and train for jobs of the future.

Many of the best-known job forecasters today issue a strong warning that our schools and colleges are turning out people who are experts in the industrial management practices of past decades, but not the near or distant future.

They predict that while the life of a new technology used to be ten years, change is coming so fast that technical occupations could become obsolete in only two years. As a matter of fact, an inestimable number of jobs, whose titles are recognized today, are already obsolete, and exotic-sounding, new occupations are either here now or on

the horizon. Some of those occupation titles are energy technician, industrial laser process technician, industrial robot production technician, materials utilization technician, genetic engineering technician, bionic-medical technician, energy auditors, computer axial tomography technician/technologists...the list goes on and covers every aspect of our lives.

What does all this say to those of us in the community college field? To me, it throws out a challenge for every day and every year that our college is in existence.

All of us know how the American steel industry has fallen on hard times. It did not make full use of the new technologies that were developed. But the Japanese steel industry did--changing technology every three years--and the Japanese have taken a good share of the world market while the American steel industry is a small fraction of what it used to be.

I could cite many other instances of change, just as you can, but let me mention just a couple. It used to take two tons of paper (yes, two tons) to design an M1 tank for our Defense Department. With today's technology, that information can now be put on one large scale integration chip--we know it as a silicon chip. It used to take four years to design a new American automobile. With today's computer-aided design technology, the re-design time is one year.

For decades we have talked about the two types of "collars" in the employment market. Today, someone has said, there are three--white, blue and steel! Robotics has added a new dimension to the employment picture, hasn't it?

Robotics has added a new dimension to the educational picture also, for we must equip workers to program and manage these steel servants--and we must retrain those displaced by the new technologies,

as well as pretrain for the jobs that future technological change will bring.

Meeting the challenge of training for the jobs of the future can be accomplished only with the full support and blessing of business and industry in your area.

We are currently going through a very exciting period of transition in our college--an experience I'd like to share with you.

Recognizing and accepting the challenge of high technology, our college has established an Advanced Machine Tool Resource Center, in conjunction with the South Carolina TEC System. This Center is assigned a four-fold mission: to develop and offer qualified students advanced training in machine tool technology; to offer needed instruction to high technology industries throughout the state; to serve as a resource to attract new high technology industries to the state; and to train faculty from all technical colleges in the state in the techniques of programming and operating Computer Numerical Control (CNC) machine tools.

While the relationship between Greenville Technical College and business and industry has always been good, the development of this Center brought new contacts and mutual benefits to all involved.

A nine-member statewide advisory committee representing industry and even the U. S. Navy contributes advice and expertise to the Center. The Naval representative lives more than 200 miles away, but enthusiastically adds depth and perspective to our panel--and has missed only one quarterly meeting! It helps to show the scope of interest and cooperation brought about by the Center.

Each week brings at least two groups of industry and/or educational leaders to the campus and, without exception, they agree that the Center is the most important development in the field of machine

tool technology training in the country. These groups come from as far away as Maine and Illinois and foreign visitors have included several German Industrialists.

Industry's keen interest is reflected in the consignment of more than $500,000 in high-tech equipment to the Center from one company--Cincinnati Milacron--and additional funding from other firms, as well as the state and federal agencies involved in these programs. In the college's Engineering Technology Division alone, more than $4 million in equipment has been added in the past 18 months through grants and donations and our aggressive efforts to upgrade and update.

A Computervision computer-aided design (CAD) system (worth almost a million dollars in equipment donated by that company) has been in use for more than a year now and is being upgraded even more to provide state-of-the-art training. A $300,000 instrumentation laboratory is being used to train instrumentation technicians, and we are told it is the only one of its type in the country in an educational setting. An Automated Manufacturing Technology Program is being developed to offer training in estimating, scheduling, inventory control, process planning, CNC metal cutting, instrumentation, and robotics.

Industries participating in continuing education classes include nationally recognized design, engineering and construction firms, electronic and communication equipment makers, textile and chemical manufacturers and others.

The combination of Computer Aided Design (CAD) equipment and Computer Aided Manufacturing (CAM) equipment has resulted in the completion of a total CAD/CAM Center on the Greenville Technical College campus. The institution now has the capability of transferring computerized design directly to the computerized manufacturing area with no loss of time or space, a capability that has been one of the main

objectives in the intricate process of reaching this pinnacle of highly technical instruction. And now, a new facility is under construction to house this CAD/CAM Center, directly adjacent to other high-tech laboratories.

To maintain the quality of instruction on the same high level as the equipment, members of our faculty visited advanced industrial plants throughout the nation for special training. They returned to our campus to teach other instructors in South Carolina technical colleges as well as initiate classes for men and women in the industry. Our faculty training has been further intensified by return-to-industry programs made possible, again, by well-developed relationships with industry.

The questions you may ask are how an educational institution can maintain a position abreast of or ahead of industry in training for jobs perhaps not even on the planning board yet and how can equipment be obtained that is current or even futuristic.

Let me mention briefly some special sources that have been most helpful. We are fortunate to have a progressive Board of Directors which has moved our institution forward at a pace needed by industry of our area. As I have described, industrial leaders have been most cooperative in providing state-of-the-art equipment that enables us to provide training that is needed today. Moreover, we have had the support of the S. C. State Board for Technical and Comprehensive Education and important government agencies.

Another development of which we are proud is a network of advisory committees working with each curriculum program to maintain and promote contacts with business and industry and to evaluate the effectiveness of each program.

For example, all programs have their own advisory committees.

They meet at least three times each year and provide an annual written evaluation of their specialty's program, its facilities, equipment and, importantly, the faculty. They have also been successful in obtaining scholarship funds to enable deserving students to attend the college and encouraging the donation of impressive quantities of equipment.

These committees involve approximately 500 professional and technical people who visit the campus and make themselves part of the college program throughout the year. For example, computer programming professionals from Metropolitan Life Insurance Co. recently spent over 200 man-hours reviewing the computer programming curriculum.

The importance of these committees is emphasized at the Greenville college in two ways. We have a full-time person whose sole responsibility is the coordination of the work of these committees, and we know of no other college with a staff person so assigned. The importance of the evaluations prepared by advisory committees is recognized by the Board of Directors which, in response to college administrators' suggestion, has created a review committee to study and follow through on such reports.

Other groups who give of their time and expertise in instructional upgrading are working practitioners from specialized firms who work as DACUM (Developing a Curriculum) committees for updating, revising, and developing curricula as new programs are planned and as established programs are refined.

We also make use of consultants in professional fields, who enable us to broaden our perspective and become worldwide-conscious, not just South Carolina-conscious.

Let me point out that our efforts in the high technologies and in the upgrading of vocational and technical education are not con-

fined to only the one-and two-year programs that Greenville TEC itself offers. I believe Greenville TEC is unique in the breadth of its connections with other levels of education.

Our relationship with and support of vocational high schools in our service area has continued strong through the years and has proved immensely valuable to both us and those fine career centers. The relationship begins with the very top administrators of both organizations, with the Superintendent of the vast Greenville County School System and the Chairman of its Board of Trustees serving on the Greenville TEC Board. The school system and Greenville TEC have cooperated in seeking--and getting--mutually beneficial federal grants, such as an articulation grant that moved us years ahead in curriculum articulation and that provided the initial means for hiring jointly a full-time coordinator. This coordinator's job is to develop and follow through on parallel curricula, even to the point of establishing an exchange of lesson plans in many programs.

We assist these career centers in acquiring equipment and, in some cases, supply many of the materials they need in their hands-on workshops and laboratories. The cooperation extends into the aforementioned advisory committees, with instructors from the career centers serving on our committees, having input into all activities and taking ideas and recommendations to their own schools.

In addition to this cross-utilization of equipment and personnel, faculty and administrators from these vocational centers visit the Greenville TEC campus at least annually, to examine equipment and programs and to consult with, on a one-to-one basis, faculty and department heads, all with the objective of promoting and upgrading vocational education and learning in-depth the requirements which the workplace has for such training. And, along the same line, students

in the career centers are invited on field trips to our campus, so that they are familiar with what they can expect when they enter advanced levels of their chosen programs.

At the other end of the spectrum is our institution's broad involvement with major universities in our state, and I would like to describe that involvement.

Some time ago, an important needs survey revealed a shortage of four-year degreed engineers in the Greenville and Upstate area. Again, because Greenville Technical College is the only state-supported post-secondary institution in this populous, highly industrialized area, studies were done to find a way to make four-year engineering education available, without students having to commute to other cities. From the standpoint of time and money--work and family obligations--such commuting is an expensive proposition.

The solution is that Clemson University is now offering, on our campus in Greenville, upper division courses leading to the baccalaureate degree in four engineering disciplines and computer science. The benefits from this arrangement for students, taxpayers, and all concerned are enormous, and students can complete these four-year degrees without ever leaving the Greenville TEC campus--a special benefit for working people and a real tuition break for students who pay Greenville TEC's low tuition fees for the first two years of study. Clemson is also offering upper division courses leading to the Bachelor of Science in Nursing and graduate level accounting courses.

In addition, the University of South Carolina offers upper division courses leading to the baccalaureate degree in Criminal Justice, courses related to the Bachelor of Science in Nursing, plus an MBA program through S. C. Educational Television--also on our campus.

Addressing the advances and demands in the allied health field,

the Medical University of South Carolin has programs--on our campus--leading to the Master's Degree in Health Administration. Plans are developing to offer bachelor's degrees in radiology, respiratory therapy, and dental hygiene--programs in which Greenville TEC offers associate degrees.

I tell you this to show the many ways in which our college is preparing for the challenges that face all of us. It all takes proper planning, flexibility of program offerings, cooperation between institutions and industry, and full community support--support that Greenville TEC has earned in full measure.

I hope the experiences recounted here today have been of some assistance to you and have stimulated some thinking. You and I are caught up in one of the most exciting eras in history. It is our opportunity to retrain thousands of American workers so that they can enter new occupational fields. It is also our challenge to provide workers for jobs that are opening in the burgeoning communications industry, jobs that may not even have a title today or may not be in existence for another few years.

Arnold Toynbee, the great historian, once described the rise and fall of nations under conditions very characteristic of the challenges to our nation today. "A young nation," he said, "is confronted with a challenge for which it finds a successful response. It then grows and prospers, but, as time passes, the nature of the challenge changes and, if a nation continues to make the same once successful response to the new challenge, it envitably suffers decline and failure."

Our nation will make a new and successful response to the new challenges that confront us today, and education will be the basis for that successful response. Our future depends on it!

HIGH TECHNOLOGY TRAINING: RECENT ACCOMPLISHMENTS

Dr. Howard Turner, Dean, Engineering Technology Division
Greenville Technical College

Introduction

The single most important development in technology in the past 50 years is the use of the computer in every technical field. Computers are now used to control metal cutting machinery, typewriters, automobiles, the drafting process, and every kind of industrial process imaginable. The challenge is to keep pace with this rapidly moving target. Greenville Technical College has made some exceptional progress in the past three years toward keeping up with developments in high technology. This discussion will detail the progress that has been made. Areas of discussion will be as follows: computer numerical control (CNC) metal cutting, computer aided design, process control/instrumentation, microprocessors, computer electronics, computer programming, and office automation.

CNC Metal Cutting

Greenville TEC was selected as the site for the Advanced Machine Tool Resource Center as part of the S. C. State Board for Technical and Comprehensive Education's "Design for the Eighties" program. More than $900,000 in high-tech equipment and an enthusiastic, well-trained staff are rapidly earning the Center a reputation for excellence in this technology so vital to modern manufacturing techniques.

Occupying 4,050 square feet in the Engineering Technology Building, the Center consists of programming and machine operation laboratories with the most modern, up-to-date labs in the Southeast. A new addition to the present building increases the Center's capacity and accommodates growing enrollments.

The Resource Center is designed to serve as the primary research and development site to keep the entire state abreast of the advancing technology related to the machine tool industry. The purpose of the Center is four-fold: (1) to develop and offer to qualified students advanced training in machine tool technology, (2) to develop and offer needed instruction to existing high

CNC Metal Cutting (continued)

technology industries throughout the state, (3) to serve as a resource to attract new high-technology industries to the State of South Carolina, and (4) to train faculty from all technical colleges across the state in the techniques of programming and operating Computer Numerical Controlled (CNC) machine tools.

The Center presently houses the following equipment:

- "Numeridex" programming stations (5)
- Bridgeport Series II CNC milling machine (1)
- Tree CNC Turning Center (1)
- Cincinnati Milacron Turning Center (1)
- Cincinnati Milacron Horizontal Machining Center (1)

Curriculum courses with hands-on training leading to certificates are offered for those wishing to train or upgrade as CNC Machine operators, programmers and electrical maintenance technicians.

CNC Machine Operator Certificate Program

MTT 130 Machinability of Metals - 33 hr. course
MTT 117 Fundamentals of NC Programming - 66 hr. course
MTT 218 CNC Machine Operations I - 66 hr. course
MTT 110 Manual Programming - 55 hr. course
MTT 226 CNC Machine Operations II - 55 hr. course
MTT 236 CNC Machine Operations III - 55 hr. course

Option - CNC Programmer Certificate Program

MTT 210 CNC Computer-Assisted Programming I - 77 hr. course
MTT 220 CNC Computer-Assisted Programming II - 88 hr. course
MTT 230 CNC Computer-Assisted Programming III - 99 hr. course

A state-wide advisory committee guides the development of the Center. A two year associate degree program in Automated Manufacturing Technology will begin this fall.

Process Control/Instrumentation

About a year ago, Greenville Technical College installed a $300,000 process control/instrumentation laboratory. Included in the laboratory are four stations: pressure, temperature, level, and flow. Four remote workstations also are used to

Process Control/Instrumentation (continued)

control the stations or to work with individual controllers. Computer equipment has been added to enable the teaching of programmable controllers and distributed networking.

Presently, the instrumentation courses are given as service courses to the students in electronics, mechanical, and Design Engineering Technology programs. This fall a new two-year program called Instrumentation Engineering Technology will begin.

The instrumentation courses included in the program follow very closely the guidelines set forth by the Instrument Society of America. This entire project has lasted seven years. An advisory committee has worked closely with us on every stage of the process including equipment selection, program design, and staff selection.

Computer Aided Design (CAD)

Greenville Technical College started teaching courses in computer aided drafting and design approximately one year ago. The CAD system that is being used is a Computervision system valued at over $1,000,000. Computervision donated a large part of the system to the college. The remainder of the system was purchased with federal and local matching funds. Computervision also donated all of their software for the system including the following packages as examples:

- mechanical design
- architectural design
- concrete footing design
- structural steel
- printed circuit
- integrated circuit
- computer numerical control metal cutting
- finite element analysis
- solids modeling

Computer Aided Design (CAD) (continued)

Courses have been integrated into our Engineering Graphics Department and we are in the process of adding CAD courses in many of our other engineering technology programs. Faculty training was accomplished by sending selected members to Computervision's schools in Massachusetts, by bringing in CAD experts to teach us the fundamentals, by using programmed instructional materials, and by returning some of our faculty to industry.

The system is now located in temporary quarters but will be moved to the new CAD/CAM building this summer. Plans are to integrate the system with the machinery in the Advanced Machine Tool Resource Center giving a fully operational CAD/CAM system.

Microprocessor Laboratory

A new microprocessor laboratory is being equipped. At this point in time the following equipment has been installed:

- (8) Zenith Z-100 microcomputers
- (1) Hewlett Packard Microprocessor Development System
- (1) Hickock microprocessor trainer
- Various logic and memory trainers

This is an area that we expect to grow rapidly and therefore we intend to focus attention on this technology.

Students are taught the fundamentals of microprocessors including programming them and interfacing them with various types of mechanical devices. One such mechanical device that is interfaced is the robot. Our new robotics laboratory contains four Rhino robots, one Hero robot, and a Bucaneer robot donated by Platt Saco Lowell. Emphasis is placed on robot applications.

Computer Programming

Computer programming has been housed in the Business Division. It has been over the years slanted toward data processing. This past year it was upgraded to a more comprehensive approach. Equipment acquisitions include:

32 Burroughs terminals
32 Terminals time shared with Clemson University
18 Digital Rainbow 100 microcomputers
20 Apple IIe microcomputers
A Vax 11/780 has just been installed.

The program now has 379 students. In addition, Apple laboratories have been set up for computer aided instruction in the Adult Education Division. The Engineering Technology Division has also set up its own Apple laboratory. Two computer programming courses are taught to most Engineering Technology students. The first is an introduction to BASIC and the second is a course in engineering applications of computer programming. This laboratory is kept open for student usage and students are encouraged to utilize the computer in their problem solving courses.

Office Automation

The college is in the process of installing two complete word processing laboratories featuring 24 Dec-mate II personal computers and 12 printers. These will be interfaced with the Vax 11/780. Examples of applications that will be available are:

electronic mail
electronic messages
central dictation
calendar management

The tie in with the Vax will allow access to the Vax data base as well. This project is valued at around $500,000 including the Vax. The funds came through at least two federal grants and included matching local funds.

Computer Electronics Technology

This new industrial technology program began in the Spring of 1982 with 51 students. Since that time the enrollment has more than doubled. The purpose of the program is to train students to service and maintain computers. A new facility has been completed to house this program and over $150,000 worth of equipment has been acquired. In addition, extensive donations of computer equipment have been given by industry.

Conclusion

Significant progress has been made during the past few years toward keeping pace with high technology. Over four million dollars worth of equipment has been installed. Over half of this amount has come from donations by industry. Much of the rest was a result of federal grants. Two companies, Computervision and Cincinnati Milacron were responsible for over one million three hundred thousand dollars worth of donated equipment.

One of the keys to the success of these projects is the active involvement of the industrial community through the use of active advisory committees.

Greenville Technical College has upgraded to current technology in most areas. Future plans are to continue with this upgrading and also to move into some new state of the art technical areas. Melvin Smith will discuss our future plans with you now.

Meeting the Challenge of High Technology

Melvin Smith
Director
CAD/CAM Center
Greenville Technical College
Greenville, South Carolina

The Greatest Development Since Electricity

The large-scale implementation of computer and computer-controlled systems in the manufacturing industry is creating a second industrial revolution. The use of Computer-Aided Engineering, Computer-Aided Design, Computer-Aided Manufacturing (CAE/CAD/CAM) and Robotics is one of the greatest technological developments since the introduction of electricity.

This industrial revolution's impact has been described as the muscle of the manufacturing worker. This impact is now upon us and will amplify the creative abilities of engineers, designers and manufacturing personnel.

What is Automation?

Present day automation usually implies the use of computers in both the design and manufacturing of products. In the broadest sense, this includes everything from specifying the product characteristics needed to meet marketing objectives, to enumerating the details of how a product is to be designed, manufactured, tested and field-supported.

CAD/CAM forms the nucleus of the overall automated manufacturing industry. It is the technology concerned with the use of computers to perform certain functions in the design, production and handling of products.

With CAD/CAM, it is possible to integrate and automate virtually every aspect of a firm's operation, greatly increasing production efficiency. CAD/CAM determines how products are made, marketed, and serviced.

This technology is moving in the direction of greater integration of design and manufacturing to complete the fully automated manufacturing facility.

Insufficient Number of Engineering Graduates

Business, education and industry must become a focal point to bring about needed improvements in scientific, engineering and technological literacy of our youth, as well as the presently employed and unemployed adult. There is an insufficient number of engineering and technological graduates in the United States and a struggle of our schools to update their facilities, equipment and a shortage of qualified faculty.

In the U. S. there are only 70 engineers out of every 10,000 citizens, and a need to fill more than 253,000 engineering jobs. Out of every 10,000 citizens in Japan, for example, 400 are engineers and scientists, and three are accountants. One is a lawyer. In the U. S. there are only 70 engineers out of 10,000 citizens. Forty, however, are accountants and 20 are lawyers. Only six to seven percent of our undergraduate degrees are being awarded in the engineering disciplines. Japan is awarding 21 percent, the Soviet Union 35 percent and West Germany 37 percent.

At least half of our high school graduates never had a single year of chemistry or physics. Beyond the 10th grade, only six percent of U. S. students take math. Average S.A.T. scores are down 17%

Math and Science are the basic building blocks of technology; if they decline any further in the U. S., our future as an economic power will be jeopardized.

A Rich Opportunity Mix

Automation has produced a tremendous shortage of skilled manpower. According to recent reports and studies published in Occupational Quarterly, Futurist, and various electronics, computer, CAD/CAM, machine tool, and other engineering trade journals,

there will be a steady increase in the demand for skilled automated manufacturing technicians.

Present industries are now in the process of automating their manufacturing processes through greater use of computer and robotic equipment. As more new plants are constructed, the world-wide demand for skilled technicians will increase.

Future Growth in Employment

The Defense Department foresees shortages as soon as 1985 in the number of engineers, electronic technicians, computer programmers and machine-repair specialists.

The June 1983 issue of The Futurist published a list of present and future job opportunities as related to automated manufacturing, along with a projected percent of growth in employment demand within the next five years.

Occupation	% Growth in Employment
Data Processing Machine Mechanic	+157.1
Computer Systems Analysts	+185.4
Computer Operators	+ 91.7
Office Machine Service Technicians	+ 86.7
*Computer Programmers	+ 77.2

*The projection has now been increased to better than 190% by 1985 for high level engineering programming.

Other "new occupations" listed by The Futurist and their national projected manpower needs are:

Occupation	No. Needed by 1985
Computer Aided Design (CAD) Tech.	300,000
Computer Aided Manufacturing(CAM) Tech.	300,000
Computer Assisted Graphics (CAG) Tech.	150,000
Industrial Robot Production Tech. (for Flexible Manufacturing Systems)	800,000

The accelerated introduction of automation into our manufacturing sector, the corresponding growth of information processing and other advanced technologies, will require more math, science and computer literacy of both the blue-and-white collar workforce than ever before. The modern world is a world of robots, computer-aided design and computer-aided manufacturing, microcomputers, optical fibers and data communications.

Within the next three years there will be a 36% increase in demand for technical graduates. This increase will be in the areas of computer and computer related fields such as CAE/CAD/CAM/CIM, and robotics.

CAD/CAM Training in Industry and Education

Both industry and education are engaged in the training of large numbers of engineers, technicians, and designers in the fundamentals and advanced concepts of computer-aided design and computer-aided manufacturing. Each faces problems which can partly be solved by the other: industry can benefit from an improvement in education's ability to efficiently train large numbers of CAD/CAM students; education can benefit through additional funding from industry -- actions made possible by cost savings resulting from the employment of CAD/CAM capable persons.

Basic Employment Needs

It is impractical and probably of little value to formulate a list of all the high technology occuptions or technical training programs. It is more appropriate to identify the principle characteristics of high technology and apply the characteristics to curriculum design for technical education. The characteristics are identified as (1) broad knowledge base, (2) heavy involvement with computers, (3) rapidly changing technical content, (4) system-oriented emphasis, (5) basic understanding, and (6) employee flexibility.

Today's technicians in modern industries need to know more than that required to complete the obvious task and procedures associated with their jobs. Employers recognize that the complexity of today's equipment extends well beyond the simple, fail-safe devices of yesterday. Consequently, the trend today must be to prepare technicians or operators who understand the entire system with which they work and the technical principles that govern the behavior of each device. Furthermore, technicians must realize that, in changing one parameter in a large system, the entire system may be altered or affected as a consequence.

Many modern industrial processes have become highly automated. Repetitive task in machining, assembly, painting, welding, and testing are accomplished by automated machines or industrial robots. These processes, machines, and robots are controlled by sophisticated computers. Other high technology occupations require rapid access to enormous banks of information and the ability to assimilate and analyze data in "real time". Technicians, working with automated equipment or data-management systems, must be able to use both the

software and hardware of computer systems and microprocessors. The development, installation, calibration, troubleshooting, and repair of most computerized equipment require the combination of knowledge and skills found in computer programming and digital electronics.

In the past thirty years, the evolution of science and technology has been characterized by rapid growth and advancement. Recent advances in data communications and microelectronics have enabled engineers and technologist to have, at their finger tips access to vast amounts of information, as well as their own personal computers. This capability assures us that our technologies will continue to grow and change at unprecedented rates; and, clearly the need for our country to remain competitive on the industrial marketplace requires that technologies advance.

The personal experience of many of us in fields such as CAD/CAM, Computer Programming, Data Communications, Microelectronics, and Instrumentation has revealed that approximately fifty percent of a technical specialty will change every three or four year. As educators, we must prepare technical workers with a broader technical, mathematical, science and communications base so that they can continue to learn new techniques and assimilate new information after they are employed.

A careful examination of scienfic hardware and modern industrial processes reveals complex systems that may be composed of electrical, electronics, high level software, mechanical, pneumatic, hydraulic, thermal, and optical devices. The technician who works with high technology equipment and systems must have a broad technical background. Specialists in these areas are still required, but the

greatest need is the "super tech" who can specify, install, operate and maintain systems that may incorporate combinations of electronics, digital circuits, computers, mechanisms, hydraulics, and various transducers. Technicians with interdisciplinary skills and knowledge do not just emerge. They must be prepared through well-designed programs that include the broad knowledge base required to apply the needed interdisciplinary skills.

Role of the Automated Manufacturing Technician

Automation specialists are well-trained in computer programming and applications, automated manufacturing processes and systems, robotics, and engineering principles. They work very closely with the engineering staff. Both use CAD/CAM in every area from the single automated application, to full-scale plant automation.

The Automation Revolution

The automation revolution has produced a tremendous shortage of skilled manpower. New automation technology has grown far more rapidly than the number of personnel able to use and maintain it; this clearly has been the case for CAD/CAM.

Key personnel skills are needed in every organization to make effective use of a complex technology.

The use of computers to operate and control machinery in the manufacturing process can reduce labor requirements, maximize raw material use, and lower production cost substantially.

CAD/CAM Center

Greenville Technical College is meeting this new challenge in high technology through the new CAD/CAM Center, the addition of two new programs: Automated Manufacturing Engineering Technology and

Process Control/Instrumentation Engineering Technology, as well as upgrading the Electronics Engineering Technology, the Mechanical Engineering Technology, and other departments within the Engineering Technology Division.

The CAD/CAM Center was formed in the fall of 1983 and will be in a new 12,000 square foot facility by the fall of 1984. The CAD/CAM Center at Greenville Technical College was a major milestone in the institution's work with and for business and industry. It is the product of cooperative efforts between Greenville Technical College and the business and industrial community.

Seminars and courses at various levels are offered in the Center for numerous groups with specific needs. Among these groups are:

1. Executives who want to become more familiar with CAD/CAM to determine the benefits their companies can derive from moving into this technology.
2. Engineers, designers, and technicians who wish to acquire or upgrade their skills in CAD/CAM for advancement in their present positions or for possible career changes.
3. Students who wish to enter into and excel in careers in automated manufacturing.
4. Educators desiring courses in CAD/CAM for professional development.
5. Anyone interested in acquiring knowledge on one of the most significant advances in computerized design and manufacturing.

The objectives of the Center are to:

1. Provide management with awareness of the essential role of CAD/CAM technology in modern industry.
2. Encourage industry to adapt CAD/CAM technology in order to achieve increased productivity and to reduce manufacturing costs.
3. Serve as a professional forum and resource center for identification of trends and new concepts in the field of high technology.
4. Provide a prepared work force to fulfill the high technology employment needs of existing industry and business and to attract new business and industry to the area.

The CAD/CAM Center is well equipped with the latest industrial standard equipment. Major equipment in the Center is:

*Computervision CAD System:
- ·200-X computer
- ·Seven work stations
- ·CADDS 4-X software
- ·Complete equipment and software to interface with the CNC machine tools and robots
- ·Drum Plotter

*Cincinnati Milacron Cinturn CNC turning center
*Cincinnati Milacron T-10 CNC machining center
*Bridgeport Series II vertical milling machine
*Tree turning center
*Tree Numeridex 7000 computer assisted programming stations
*Two Numeridex manual programming stations
*One microcomputer lab
*One minicomputer lab
*One robotic lab (6 robots and controllers)
*One Process Control/Instrumentation lab

Resource Center

The Advanced Machine Tool Resource Center, included in Greenville Technical College's CAD/CAM Center is a major attraction to industrialists.

Groups of business and industrial leaders visit this training center for CAD/CAM every week; and, without exception, they agree that this is one of the most exciting developments in the field of Machine Tool Technology.

Greenville TEC was selected as the site for Advanced Machine Tool Resource Center as part of the South Carolina State Board for Technical Comprehensive Education's "Design for the Eighties" program. More than a million dollars in high-tech equipment and an enthusiastic, well-trained staff are rapidly earning the Center a reputation for excellence in this technology so vital to the modern manufacturing techniques.

Occupying 4.050 square feet in the Engineering Technology Building, the Center consists of programming and machine operation laboratories with the most modern, up-to-date labs in the southeast. The new addition to the present building will increase the Center's capacity and accommodate growing enrollments.

The Advanced Machine Tool Resource Center is designed to serve as the primary research and development site to keep the entire state abreast to the advancing technology related to the machine tool industry. The purpose of the Center is fourfold:

(1) to develop and offer to qualified students advanced training in Machine Tool Technology,

(2) to develop and offer needed instruction to existing high technology industries throughout the state,

(3) to serve as a resource to attract new high-technology industries to the State of South Carolina,

(4) to train faculty from all technical colleges across the state in the techniques of programming and operating Computer Numerical Controlled (CNC) machine tools.

Working Together Closely

A major contribution to Greenville Technical College's success over the years has been its close working relationship with local business and industry.

For example, advisory committees, comprised of groups of business and industry, play a vital role in the institution's decision making process in keeping the programs closely attuned to community needs. These committees constantly evaluate their particular programs, ensuring that curriculum, faculty, equipment and facilities remain up-to-date.

Before any program is implemented, a steering committee conducts a needs survey to learn if a need for the program exits. Such a survey indicated an overwhelming need in the Greenville area for an Automated Manufacturing Technology Program and Process Control/ Instrumentation Technology. More than one hundred area industries were surveyed, with 88 responding to the survey along with letters of support for these new programs.

In September 1984 Greenville Technical College will implement these two new programs in high technology. The two new programs will be seven quarters and offering an Associate of Engineering Technology Degree.

The planning and development of these new programs was approximately one year in length. Each program was designed to meet the needs of business and industry for the present as well as what is to be expected within the next five years. The programs were developed through a very close working relationship with advisory committees and the local industry. Once the advisory committee was formed, a needs survey was conducted and analyzed. The next step was to perform a DACUM (Develop A Curriculum) in order to have the best possible

curriculum and fulfill the needs of the local and area industry.

Automated Manufacturing

The Automated Manufacturing Technology Program at Greenville Technical College prepares students for entry-level positions as application specialists in automated manufacturing systems, performing a wide range of task. Students work in the areas of specifying, installing, checking out, interfacing and operating various types of automated industrial equipment.

Students are given a broad technical and mathematical base, so that they can continue to learn new techniques and assimilate new information after they are employed.

Graduates of the program can expect to find employment with a large variety of industries. These include chemical, pulp and paper, power and various manufacturing industries.

State-of-the-Art Facilities

Automated Manufacturing Technology students receive hands-on training in the state-of-the-art facilities. These include the new CAD/CAM Center, microcomputers, high level computer software, and the new Process Control/Instrumentation lab.

A High-Tech Curriculum

After seven quarters of study, Automated Manufacturing Technology students can earn as Associate Degree in Automated Manufacturing Technology. Areas of study include:

*Electricity/Electronics
*Digital Electronics
*Microprocessors
*Computer Programming
*Computer Aided Design (CAD)
*Computer Aided Manufacturing (CAM)
*Robotics

*Process Control/Instrumentation
*Computer Numerical Control (CNC)
*Mechanics
*Manufacturing Processes
*Algebra, Trigonometry, Geometry, and Calculus
*Chemistry and Physics
*English, Economics, and Psychology

A Promising Outlook

The instrumentation field represents one of the fastest growing and most complex segments of the American industry. Highly-skilled instrumentation technicians are in great demand as more automated instrumentation systems are implemented.

According to a recent survey, there are currently some 800 businesses and industries in the Greenville service area alone using process control systems. Contact with major industries across the state indicates a need for 400 or more additional technicians per year.

What is Process Control/Instrumentation?

Process Control/Instrumentation is defined as the use of a mechanism in an industrial process or operation which:

*senses some physical variable
*measures the amount of the variable
*monitors the measurement
*responds by making an adjustment in the final element affecting the control

Instruments extend human senses and control in such areas as space exploration, missile guidance, environmental control, automated processing and production, and many other areas of applied science.

Instrumentation in Industry

Applied instrumentation in modern industry research or processing has become increasingly complex.

The automated petroleum refinery is an example of a complex

industrial instrumentation system. An analog or digital computer is built into the system to completely automate operation and control. Whole systems are interconnected for transmitting, acquiring, and reducing data and standardizing performance.

Highly complicated instruments are currently in common use measuring such variables as pressure, flow, level, temperature, force, sound, and light.

Role of the Instrumentation Technician

Skilled instrumentation technicians must be capable of working closely with instrumentation engineers and scientists and must have the capability to supervise and coordinate the efforts of skilled craftspeople and instrument maintenance personnel. These capabilities allow technicians to be effective members of the scientific team. The technician's work is to plan, assemble, install, calibrate, evaluate, and operate instruments as they apply to processes or systems.

The Greenville TEC Program

The Process Control/Instrumentation Technology Program at Greenville Technical College is designed to prepare the student for entry-level positions as instrumentation engineering technicians performing a wide variety of task. Students work with systems that incorporate combinations of computers, electrical systems, hydraulics and pneumatics, as well as interfacing multi-systems and transducers.

Students are given a broad technical and mathematical base so that they can continue to learn new techniques and assimilate new information after they are employed.

Graduates of the program can expect to find employment with a large variety of industries. These include textiles, pulp and paper,

chemical, power, and other manufacturing industries, as well as engineering firms.

State-of-the-Art Laboratory

Greenville Technical College offers training in the most up-to-date facilities. This lab, with equipment valued at $212,500, is believed to be the only one of its kind in a college or university in the country.

Coverning over 822 square feet of laboratory space, equipment includes four calibration stations; pressure, temperature, flow, and level stations; extensive computer equipment; and a number of cut-away devices used for demonstrations.

An advisory committee comprised of members of the instrumentation industry specified design of the facilities and assisted the college in employing Quintech Corporation of Canada to build the lab.

The Greenville TEC Process Control/Instrumentation lab is unique in many ways: (1) it uses any major manufacturer's instrument interchangeably; (2) it simulates actual industrial processes; and (3) various faults can be inserted for students to learn trouble-shooting. Any level of instruction in instrumentation can be taught with this state-of-the-art equipment.

A High-Tech Curriculum

Process Control/Instrumentation Technology students attend Greenville TEC for seven quarters to earn an Associate Degree in Process Control/Instrumentation Engineering Technology. Areas of study include:

*Electricity/Electronics
*Digital Logic
*Computer Programming

*Instrumentation
  - Measurement Principles I and II
  - Control Principles I and II
  - Calibrations and Standardizations
  - Advanced Automatic Controls
  - Control System Design
  - Process Design

*Fluid Power
*Electrical Machinery
*Automated Manufacturing Systems
*Algebra, Trigonometry, Geometry, and Calculus
*Chemistry and Physics
*English, Economics and Psychology

Meeting the Challenge

Rapid advancements in the various fields of engineering technology and the resulting changes in CAD/CAM, Automation, Electronics, Computers, and Instrumentation demand that technicians have sufficient knowledge of the underlying engineering principles to keep abreast of the evolving technology. The CAD/CAM Center, Automated Manufacturing Technology, Process Control/Instrumentation Technology, Electronics Engineering Technology, and many other departments at Greenville Technical College with the state-of-the-art equipment and high quality training, are designed to meet this challenge.

The Coming Years

According to a survey by Daratech Associates, a CAD/CAM research organization, CAD/CAM industry revenues topped $1.7 billion last year, with an annual growth rate of 32% up from 28% in 1982. This same market according to Frost and Sullivan, is expected to jump to over $6 billion by 1987 and $23.3 billion by 1992.

During the 1984-85 school year Greenville Technical College anticipates spending approximately $1 million on the CAD/CAM Center and upgrading the present electronics laboratories to the latest state-of-the-art equipment. Areas of expenditure will be for: robotic equipment, vertical machining center, coordinate measuring machine, CNC grinding machine, electronic tool gauge, CNC training controls, CNC training simulators, electronic test equipment, minicomputer and manufacturing software.

The CAD/CAM Center will be in the new 12,000 square foot facility before September 1984. Commencing with the fall quarter, there will be a number of newly developed CAD and CAM courses offered for the first time. The CAD courses are developed on the Computervision 200-X using CADDS 4X software; these courses are both 2-D and 3-D courses. Beginning courses are being developed using the Zenith Z-100 microcomputer and AutoCAD software. These courses are basic 2-D drafting and design courses.

The new CAM courses are CNC maintenance, CNC programming using APT and COMPACT II software as well as graphic programming, automated manufacturing software, and robotics.

According to recent surveys there is a need to train more than 100,000 CAD based designer/drafters during the next four years. Greenville TEC's CAD/CAM Center recently completed a proposal to the

Job Training Partnership Act (JTPA) to retrain or upgrade 100 designer/drafters to entry level CAD operators. This program is expected to begin in July 1984 and run for ten weeks.

During the 1984-85 school year the CAD/CAM Center will be conducting a number of seminars and short courses on CAD, CAM, robotics, instrumentation, and high-level computer programming. Each seminar and short course is designed to meet the needs of the local and area business, industry, and educators who are interested in upgrading their skills.

Return to Industry

The recently proposed two new programs, Automated Manufacturing Technology and Process Control/Instrumentation Technology, will begin with the fall quarter. To prepare for the new programs the faculty involved will return to industry and special schools for the summer to become familiar with the new equipment and applications. Each of these departments will offer special evening classes for upgrading the working technician.

Greenville TEC is now considering a certificate program in Process Control/Instrumentation for the upgrading of the working technician and retraining technicians from other related areas.

In order to reach more students, faculty, and industry a mobile training unit duplicating the equipment in our laboratory is being planned. With this unit faculty from other TEC centers could be upgraded at Greenville TEC, and then request the mobile unit to be at their school for a given quarter as needed for instruction in their programs. This unit could also be made to conduct special courses for on-site industry training.

Research and Development

On March 22, 1984, Greenville Technical College hosted a joint meeting with representatives from the Governor's Office, State Development Board, State Board for Technical and Comprehensive Education, State Research Authority, and Clemson University for planning and implementing a research-applications facility within the CAD/CAM Center. This new area will have the responsiblity of research applications in automated manufacturing, faculty development, curriculum development, hardware and software modification, application testing and verification of research projects. The CAD/CAM Center will be working jointly with industry and Clemson Unviersity's Automated Manufacturing Engineering Research Center. This new area of excellence is just another step forward in South Carolina's Design for the Eighties concept.

Software Engineering

The Department of Defense on March 15, 1983, released a document titled Software Technology for Adaptable Reliable Systems. The following quote is from that document.

"The U. S. has lost its lead in many of the mature technologies upon which our industrial base and military power were built. The threat of a similar strategic loss now faces the electronics, computer and software industries. This must not be allowed to happen because we depend so heavily on computers in our mission critical military systems. Aggressive action is needed, now, if we are to maintain our military supremacy through the use of computer technology."

In 1983 alone, well over $20 billion was spent by the free world just on the maintenance of software. Many experts agree that at least half of this staggering expenditure could have been saved or used for

new automation projects if an appropriate language and programming support environment had been available when these projects were initially designed. Fortunately, a new era of adaptable, reliable software is now beginning.

After more than seven years of analysis, design, and finally development by some of the best computer professionals that government, academia, and private industry throughout the free world could master, Ada * has become a reality. For in February, 1983, the American National Standards Institute accepted Ada as an ANSI-standard language.

The year 1984 will probably be known as the year that Ada compilers were fitted to UNIX operating systems. The ada language and the UNIX operating system is at reality as standard in the U. S.

Greenville Technical College is receiving very responsive support from major computer companies in the planning of a new curriculum in Software Engineering Technology. The first full planning session with a group of hardware and software representatives is scheduled for the late April.

Once Greenville Technical College is striving to be cognizant to business and industry. Education must remain current or ahead of business and industry in this age of rapidly changing high technology.

*Ada is a registered trademark of the U. S. Government, Ada Joint Program Office.

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